In response to the mine threat in Bosnia, we have included two articles with information on route-clearance techniques. The first article expands information published in the April 1995 issue of ENGINEER. *Intended for the individual combat engineer and his leader, it describes countermine techniques used in earlier conflicts. The second article is based on current doctrinal mine-awareness training provided by the U.S. Army Engineer School.*

Photo by Tom Reeder

Techniques and Procedures for Route Clearance

By William C. Schneck, Jr. and Brian M. Green

Land mines are the major threat to U.S. forces participating in Operation Joint Endeavor in Croatia and Bosnia. The belligerents have laid an estimated 4 million to 5 million mines in the former Yugoslavia during the four years of civil war. Frequently they emplaced mines randomly along lines of communication (LOC) through this rugged country.

Overview

This is not the first time that U.S. military engineers have been required to sweep routes for randomly emplaced mines. The United States learned many lessons about route clearance during the Vietnam War and had to relearn them a few years ago in Mogadishu, Somalia. While the U.S. can't eliminate all casualties or equipment damage from mines, leaders can take steps to reduce these incidents to a minimum. An aggressive mine-awareness training program for all personnel in theater is an effective means of reducing casualties and equipment losses (see article, page 11).

Mines placed along LOC are cleared by a combined arms organization. The sweep team usually consists of engineers, infantry, armor, and/or military police. Tanks and Bradleys should follow well behind the sweep team to cover them with fire and to move forward to destroy an ambush if one is initiated. Flank security of the sweep team should also be considered.

A maneuver company commander or battalion commander normally commands a mine-sweeping operation and is responsible for synchronizing the various elements in the operation. The senior engineer present is responsible for advising the commander on engineer capabilities and weaknesses; he also supervises the subordinate engineer elements.

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Threat Considerations

The mine threat is real. To date, U.S. forces in Bosnia have had 10 mine incidents involving seven antitank (AT) mines, four antipersonnel (AP) mines and one piece of unexploded ordnance (UXO). These incidents resulted in one death and seven wounded, as well as one destroyed HMMWV and seven damaged tracked vehicles.

To fully appreciate the mine situation, it is necessary to understand and respect (as in do not underestimate) the fellow who emplaced the mines:

- He is as smart as you are and more creative.
- He is part of the Yugoslavian environment and culture.
- He is motivated to kill (not wound).
- He is politically aware and will exploit the news media.

Former combatants in the Yugoslavian civil war employed some sophisticated mine-laying techniques that are shown in Tables 1-3. Because of the threat they pose, the individual combat engineer and his leader must maintain constant situational awareness and be flexible enough to adapt their equipment and techniques to the nature of the mine threat at any given time. U.S. combat engineers need to fully understand these mining techniques and should consider adopting some of them. In many cases, the time required to employ them is not excessive.

Route-Clearance Considerations

When participating in a route-clearance mission, engineer soldiers should consider the following countermine functions. An asterisk (*) in these functions and throughout the rest of this article denotes techniques and information derived from nondoctrinal sources.

Detection. Mine detection is the most important countermine function during route clearance. However, effective mine detection takes time. *Do not* sacrifice engineers because of someone else's unreasonable impatience! Do not take any more risks than the situation requires. Nonengineers (outside the chain of command) may become unreasonably impatient at the delay caused by a mine sweep. In that case, the senior engineer should advise them of the situation and let them determine whether or not to bypass the sweep team.

Several techniques may improve mine-detection efficiency:

- Thoroughly check all suspicious areas, including road craters, bypasses, potholes, culverts, fords, intersections, turn-around areas, abandoned roadblocks, and choke points.
- Observe people along the route. Increase alertness when a normally crowded area is abandoned. If questioned, local civilians may provide critical information about mined areas. All such information, however, should be carefully verified.

Photo by 1SG Johnson

This 2 1/2-ton cargo truck from the 568th Engineer Company is protected with 1/4-inch mild steel plates, angle iron, plywood, and sandbags.

- Use binoculars to scan the route ahead to identify hazardous areas where increased alertness is needed.*
- Use abandoned mined areas to practice locating mines visually. In Vietnam, 50 percent of the mines were detected visually and 33 percent were detected with metallic mine detectors (most of them had metal cases). Watch for mine packing materials such as wood boxes, metal cans, and cardboard tubes.*
- Ensure mine-detector operators and probers are highly trained and experienced. Rotate them every 20-30 minutes. The average soldier can effectively operate a detector for one turn every 4 hours.*

- Sweep the entire road, including shoulders, to a minimum of 5 meters from the edge of the road. This width allows most vehicles to do a U-turn or to pull off to the side to allow another unit to pass. Watch for trip wires along the shoulders. ***Note:*** *Dirt and gravel shoulders, the easiest areas to mine, are the most commonly mined parts of any road in Bosnia.*
- Consider supplementing the route-sweeping teams with mine-detection or explosive-sniffing dogs with military police handlers. When employed, the handler and the dog must be considered an indivisible element. The dogs can work 3 to 4 hours in moderate climatic conditions, and this period may be extended if the dogs take a 10-minute break every hour. Dogs require special veterinary support to retain their effectiveness. They may not differentiate individual mines in heavily mined areas and may be affected by wind speed and direction. Multiple teams are needed to conduct sustained operations. The dog handlers may provide additional employment recommendations.*
- Do not assume that a road is cleared when it passes through a friendly village or outpost or if it has not been under continuous friendly observation since it was last swept.*
- When the probing methods usually employed are not sufficient to uncover mines in roadbeds of compacted rock and clay, use a knife or bayonet to chip and pry them out.*
- Remove all items on the road that cause a positive reading on a metallic mine detector in the initial phases of a sweep operation. Their removal will save time on subsequent sweeps by significantly decreasing the number of false positive readings on the mine detector.*
- Increase the size of the basic sweep team to allow one metallic mine detector for every 2 meters of road width (including the shoulders), plus two in reserve. Maintain an offset of about 25 meters between detector operators. If a positive reading is obtained, mark the location and have probers search the area with assistance from the two reserve detectors. This technique allows the primary detector operators to remain together and continue their sweep, thus ensuring complete and continuous coverage of the road.*
- When command-detonated mines are a threat, look for possible trigger points along the route and remove them if possible.*
- When command-detonated mines are a threat, position flank security well forward of the sweep element. They carefully search for wires and other signs of command-detonated mines or ambushes. If the flank element is close to a tree line, a security team should sweep the tree line ahead of the element that is checking for command firing wires. Look for disturbed earth or foliage used to cover firing wires. In Vietnam, engineers located these wires by having a soldier with each flank element drag a pick or bush hook along the ground while he moved in a zig-zag pattern between the flank element and the road.* Considering the large number of mines in Bosnia, this technique should be used only if the threat of command-detonated mines becomes significant.
- Use a leaf blower to remove light, dry snow before sweeping the ground with a metallic mine detector when conditions warrant. In this incremental process, a small patch of ground is cleared of snow before it is swept for mines, then the process is repeated. ***Note:*** *The sensitivity of pressure-fuzed AT and AP mines may be greatly reduced in snow and frozen ground. Therefore, ground that was crossed safely during the winter may become dangerous after the spring thaw begins.**

Additional threat mine-laying techniques and detection considerations are shown in Table 1, page 6.

Reporting. Timely, accurate reporting is critical to saving lives. Accurate reporting allows the battle staff to analyze and distribute information on the overall mine situation and to develop appropriate countermeasures. Consider the following guides:

- Provide a situation report at designated checkpoints and after completing a mine sweep.
- Send a spot report in a SALUTE format to the battalion tactical operations center immediately after a mine is discovered or detonates. The SALUTE report must contain an accurate location (coordinates) of the incident. Forward a written report (see figure, page 7) containing all facts and the commander's comments within 24 hours of the incident. If possible, include sketches of the site showing where the mine was, road shoulders, center of road, crater dimensions, etc. Send recovered information and materials to the S2 within 24 hours.

Neutralization. While many potential mine-neutralization hazards are obvious, some are not. Neutralization teams must proceed with caution and patience. The following techniques may be employed:

- Only one member of the sweep team will neutralize mines. All others will move a safe distance away.

Table 1. Mine-Detection Techniques

Threat	Effects	Countermeasures
Low-metal mines.	Very difficult to detect using the AN/PSS-12 metal mine detector. 1	1) Drastically reduce the sweep rate. 2) Lead with probers or mine-roller-equipped tanks and follow with AN/PSS-12 detectors. 3) Look for visual indicators. 4) Supplement sweep teams with infrared (IR) sensors.
Antitank (AT) mines stacked with dirt between them.	Conceal presence of lower mines.	Resweep the hole after lifting or neutralizing a mine.*
Stacked low-metal AT mines with only the bottom one fuzed.	The only metal in some mines is in the fuze. The depth of the buried fuze makes detection impossible.	1) Look for visual indicators. 2) Supplement sweep teams with IR sensors.*
Metal debris (such as machine-gun links) scattered across road surface.	Slows the sweep rate and makes operators complacent.	Ensure operators are highly trained, experienced, and can differentiate metallic debris from a mine.
Metal AT mine (either surface laid or buried) surrounded with a buried low-metal AP mine cluster or buried low-metal AT mines.	The metallic mine masks the presence of low-metal mines close to it.	1) Probe the area around the mine before kneeling down to investigate a possible detection.* 2) Proof the entire width of a route as a routine part of mine sweeping.*
Low-metal AT mine placed over a metal culvert.	The culvert masks the presence of low-metal mines.	1) Look for visual indicators. 2) Supplement sweep teams with IR sensors.*
AT mines placed at ford sites adjacent to destroyed bridges.	Thoroughness of the sweep decreases due to the discomfort of sweeping a cold, wet ford site.	1) Maintain a disciplined sweep technique in the cold water. 2) Use divers if available.
Minefields emplaced with a mix of inert mines.	Sweepers become complacent after locating several inert mines.	1)Treat each mine as live; the one treated as inert may be a live one with an anti-handling device (AHD). 2)To a trained ear, the Yugoslavian-made V-series training mines have a stronger signature on a mine detector than a live mine.
Roadblocks consisting of a series of earth berms with AT mines placed only in the last one.	Sweepers become complacent after clearing several berms and finding no mines.	Maintain a disciplined sweep technique.

1 The AN/PSS-12 can detect low-metal mines such as the PMA-3 and TMA-4 to a depth of about 2 inches in a laboratory environment using a slow sweep rate. One Canadian veteran of U.N. operations in Bosnia stated that they led with probes or a mine roller 80 percent of the time.

* Denotes nondoctrinal information.

- The common practice is to *blow in place* any enemy mine detected. This action often creates a large crater in the road that must be backfilled and capped. For example, craters made by TMA-3 mines are usually 12-18 inches deep and 30-36 inches across. Since cratering is inevitable, road-repair equipment and fill material must accompany the sweep team.
- In many situations, it may be preferable to extract mines located on a LOC. Removing mines allows the road to be reopened immediately, eliminates the need to repair craters, and denies the enemy an excellent location for laying their next mine (in a road crater filled with loose gravel). Additionally, mines removed using this technique pose little danger to personnel. To extract a mine, first check for stacked mines, antihandling devices (AHD), and booby traps by thoroughly searching the mine by hand. Then extract the mine using about 150 feet of parachute cord, an A-frame, and a grapnel. Pull the mine at least 1.5 meters from the hole and wait at least 5 minutes before approaching it. (See STP 5-12B1-SM, *Combat Engineer Soldier's Manual, Skill Level 1,* dated December 1990, page 2-200, for full details.) If multiple mines are extracted from an area, pick up the fuzed AT mines by hand and move them to a single point for demolition to save both time and explosives. Remember that these mines are still fuzed.*

MINE INCIDENT REPORTING CHECKLIST*

(*Possible format for inclusion in Unit's SOP)

Unit _____ Date _____

Name _____ Time _____

Exact location (include map grid/map number)

_____

Site description (for example, creek, jungle, path)_____

_____

Activity (for example, patrol) _____

How was mined discovered _____

What detection equipment was used, if any _____

_____

Mine size _____ Mine switch _____

Mine color _____ Mine markings _____

Mine casing _____ Mine contents _____

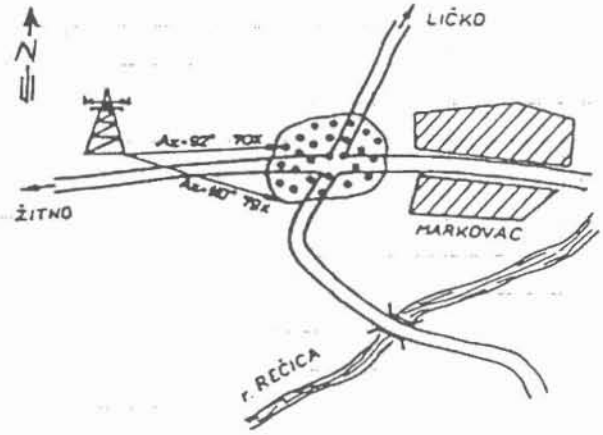
Crater size _____

Color and condition of crater _____

How camouflaged _____

Actions taken to neutralize/remove mine _____

_____



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Sample Mine Incident Report

This technique is not normally recommended for use against AP mines because of their sensitive fuzing. However, if necessary, rig the pull line so that the mine can be dragged out of the way and into a suitable area before destroying it with explosives. ***Note:*** *Do not use this technique against tilt-rod or magnetic-fuzed mines.**

- When the situation permits, much time can be saved if the finding unit (usually the lead element) marks the mines and bypasses them, leaving demolition to the follow-on supporting element. This technique reduces the sweep time. If multiple mines are to be blown in place, use a ring main or line main to reduce the demolition time.*
- When mines are blown in place, stand off about 413 meters (preferably in an armored vehicle) in case stacked or boosted mines are present.*
- Check both ends of all trip wires (both slack and taut) for "breakwire"-type fuzes before cutting them. Breakwire-fuzed mines should only be blown in place or neutralized with a grapnel.*
- After neutralizing a mine, check the hole again with a metallic mine detector and a probe in case the enemy placed more mines in the hole.*
- When firing wires or mines are detected, one soldier will immediately search for lead wires because all ordnance, including pressure-fuzed AT mines, can be rigged for command detonation. If lead wires are found, he should cut one at a time and shunt them, then continue searching for the mine.

  Alternatively, one soldier may attach additional firing wire to the wires leading into the road and then move to a safe position and try to fire the mine electrically. If the mine does not detonate or if demolition in place is unacceptable, he sweeps along the wire toward the road until the mine is found; then he removes it from the LOC using an A-frame and a grapnel. Remember that AP mines may be placed along the firing wire to protect it. If the mine is not found, he sets a row of charges on the road and blows them all.*
- When an unidentified explosive device is discovered, the commander (with his senior engineer or EOD support present) must decide if a recovery attempt is warranted. This decision must be based on the essential elements of information specified in the operations order and guidance from higher headquarters. Photograph the device before demolition if possible. If the decision is to recover an unidentified explosive device, only one soldier attempts the recovery. He digs carefully around the explosive device

Table 2. Mine-Neutralization Techniques

Threat	Effects	Countermeasures
Coupled mines (such as the Romanian MC-71 or improvised mines) where the fuze is separated from the mine body.	May be used to destroy mine plows and roller-equipped tanks.	Dismounted mine sweepers or standoff mine-detection vehicles should always precede mounted elements of a sweep force.*
Side-attack mines (such as the Yugoslavian Cobra or improvised mines).	May be used to destroy mine plows and roller-equipped tanks.	1) Flank security elements should precede mounted elements to detect and neutralize this threat.* 2) Neutralize visually detected side-attack mines using distruption by gunfire.* 3) Check carefully for AP mines when approaching this type of mine.*
AT mines fitted with AHD.	1) Discourages manual lift techniques. 2) Destroys mine plows.	1) Blow in place or use an A-frame or tripod to lift mines from a remote location. 2) Precede mounted elements with dismounted sweepers or standoff mine-detection vehicles.* 3) A strong signal on the AN/PSS-12 for a normally low-metal mine may indicate the presence of an AHD.*
Breakwire-fuzed fragmenting AP mines.	Cutting what appears to be a slack trip wire activates the mine.	Check both ends of all trip wires (both slack and taut) for unusual fuzing before cutting them.*
Low-metal AP mines laid along trip wires. (This technique is used frequently in Bosnia.)	Personnel tracing trip wires become casualties.	1) Pull the trip wire using a grapnel from a covered position a safe distance away. (Remember that the lethal range of some mines in Bosnia is 50 meters.) Then carefully sweep/probe the area that was under the trip wire. 2) Probe along trip wires; do not become overly focused on the wire.*
Multi-impulse AT mine is improvised by placing a simple pressure-fuzed AT mine upside down in a conical hole.	Mine detonates after repeated vehicle contacts force it to the bottom of the hole. Mine rollers do not reliably clear this arrangement.	1) Employ good detection techniques. 2) A circular depression is a visual indicator that this technique was employed.
Surface-laid AT mines fitted with AHDs appear to be hastily laid.	Soldiers grab the mines to throw them off the road.	1) Assume *all* mines are fitted with AHDs. 2) Use A-frame or grapnel to move mines.
Surface-laid AT mines surrounded by trip-wire fuzed Bouncing Bettys.	Soldiers activate the trip wires when they walk up to grab the AT mines and throw them off the road.	Maintain sweep discipline when approaching surface-laid mines.

* Denotes nondoctrinal information.

until a grappling hook or wire can be passed through or under it. Then he attempts to pull it with a line and a small A-frame. If the recovery attempt becomes too dangerous, he blows the device in place. Under no circumstances should anyone attempt to disarm an explosive device if the NCO in charge does not consider it safe. Do not take unnecessary risks.*

Additional neutralization techniques are described in Table 2.

Proofing. Countermine operations are rarely 100 percent effective, and mines sometimes slip through. Proofing confirms the quality of a sweep. Consider using the following proofing techniques:

- Follow each mine-sweep team with enough proofing devices to cover the entire width of the route, including the shoulders. Proofing devices include mine-roller-equipped tanks, improvised mine rollers, other tracked vehicles (the heavier the better), and loaded 5-ton dump trucks driven in reverse. (Driving in reverse reduces the possibility of serious injury to the driver if the truck detonates a mine.) The proofing vehicles maintain a minimum distance of 25 meters from all personnel in case an undetected mine detonates. Dump trucks loaded with gravel follow the mine-sweep teams and proofing devices to fill craters or potholes in the road.*
- To defeat magnetic-influence fuzed mines, fit a magnetic mine countermeasure system such as the Improved Dog-bone Assembly to the mine-

Table 3. Survivability Techniques

Threat	Effects	Countermeasures
Boosted mines (stacked with additional mines or explosives beneath them).	Increase damage to vehicles.	Lead with mine-resistant vehicles or vehicles fitted with mine-protection kits.*
AT mines laid in the road with AP mines laid on the shoulders.	Survivors of a mine-immobilized vehicle dismount into an adjacent AP minefield.	Dismount onto the road. Do not move onto the shoulders without first looking for AP mines.*
Claymore-type mines placed in trees.	Shoot down into the kill zone through the top of the vehicle.	Reinforce the top when improvising vehicle protection.*

* Denotes nondoctrinal information.

roller-equipped tank or fit the Field Expedient Coil System to the lead armored vehicles. To date, there are no reports of magnetic-influence fuzed mines in Bosnia.

- Mine rollers are extremely heavy (10 tons) and may damage unimproved roads. The heavy mine-roller-equipped tank (MLC 67) exceeds the capacity of many bridges and may be unable to negotiate choke points. Together, the task force engineer and the battalion S2 must identify bridging constraints during the planning process of a route sweep. If roller-equipped tanks are unsuitable or unavailable, improvised, lightweight expendable rollers may be used.*

Protection. As noted above, countermine measures are rarely 100 percent effective. The following procedures will reduce casualties if a mine detonates:

Mounted Operations

- Wear protective vests, helmets, and seat belts.
- Keep vehicle speeds at less than 25 mph. The emotional surprise (of the driver) and physical damage (to the vehicle) caused by a mine detonation will cause a vehicular accident.*
- Store all loose articles because they may become high-speed projectiles if a mine detonates. Leave any unnecessary equipment at the base camp.*
- Fill each tire with water about two-thirds of the way to the rim to help deflect a mine detonation. Add antifreeze to the water in cold weather.*
- Place two layers of sandbags on the floor of the vehicle cab and on the cargo bed to help protect personnel from the effects of a mine blast. Cover the sandbags with heavy conveyor belts or rubber matting to reduce secondary fragments. Do not put rocks in the sandbags because they could become secondary missiles if a mine detonates. Place sandbags on nonballistic windshields and on the hood above the dash to protect against flying glass and metal.
- Strive for a uniform appearance of all vehicles. Cross load key personnel and equipment.
- Follow the tracks of the vehicle ahead, but avoid old vehicle tracks because they may be mined.*
- Keep the hatches on armored vehicles open to vent the pressure pulse from a mine detonation.*

Dismounted Operations

- Maintain proper interval.
- Wear appropriate protective equipment (standard protective vest and helmet). When conducting countermine operations, also wear the Body Armor Set, Individual Countermine (BASIC). It includes a ballistic face shield and goggles, antifragment trousers, and blast overboots.
- Watch for visual mine indicators.
- Do not wear sunglasses because they significantly decrease the ability to spot trip wires.*

Mounted and Dismounted Operations

- Rehearse unit-developed battle drills. At a minimum, units should develop and rehearse drills to clear mines after they are detected, to evacuate casualties from a mined area, and to react to a mine detonation during convoy operations.
- After a mine incident, immediately establish all-around security and clear the area to the casualty with a sweep team. Do not cluster around casualties. A sweep team will approach casualties first, followed by an aid and litter team. ***Note:*** *Because dirt is driven into wounds and traumatic amputation is probable, medical personnel supporting countermine operations must receive additional training on the treatment of mine casualties.*
- Many units establish a procedure for mine sweeps and then never deviate from it. This practice assures the commander a thorough,

well-controlled sweep, but it gives the enemy the advantage to predict movements. He is then able to place his mines to inflict maximum damage.

- A careless attitude breeds poor security. The enemy may observe this attitude and strike when a unit's guard is down. Physically check likely ambush places. Assume good, dispersed firing positions during halts.
- Construct mine booms upstream of bridging and fording sites to counter drifting river mines.

Additional survivability techniques are shown in Table 3, page 9.

Closing

Standing in the middle of a road with an AN/PSS-12 mine detector is probably the most vulnerable position to place a soldier. Proper equipment, training, and smart leadership will reduce that risk. Remember, route clearance is a combined-arms operation that requires careful planning, coordination, and execution. Although equipment solutions have not evolved from the painful lessons of Vietnam and Somalia, solid training, patience, flexibility, practice, perseverance, and planning will reduce the loss of life and equipment caused by mined routes.

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